PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2003-005173

(43)Date of publication of application : 08.01.2003

(51)Int.Cl. G02F 1/1335
G09F 9/30
G09F 9/35

(21)Application number : 2001-190293

(22)Date of filing : 22.06.2001

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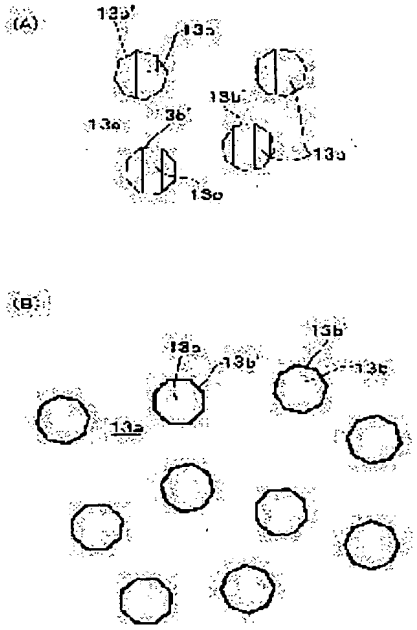
(54) ELECTROOPTIC DEVICE AND ELECTRONIC EQUIPMENT

(57)Abstract:

PROBLEM TO BE SOLVED: To provide an electrooptic device which can display an image of high quality by eliminating direction dependency of a scattering characteristic when reflected light is scattered by unevenness formed by using photolithography technology, and electronic equipment using the electrooptic device.

SOLUTION: When a TFT array substrate of a reflection type or translucence and half-reflection type electrooptic device is manufactured, an evenness formation layer 14a having holes 13b (unevenness) is formed by exposing and developing photosensitive resin and then an intermediate film and a light-reflecting film for making the uneven shape smooth are formed. At this time, the holes 13b of the unevenness forming layer 13 are patterned in a polygonal plane shape whose sides 13b' are directed at random.



LEGAL STATUS

[Date of request for examination] 02.12.2003

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

CLAIMS

[Claim(s)]
[Claim 1] The toothing stratification which forms two or more irregularity which is from a projection or a hole on the front-face side of the substrate holding electrooptic material, In the electro-optic device with which it has the light reflex film formed in the field which laps with toothing stratification and a flat-surface target concerned in the upper layer side of this toothing stratification, and two or more irregularity of said toothing stratification comes to form the concavo-convex pattern for light scattering in the front face of this light reflex film Two or more irregularity of said toothing stratification is electro-optic devices respectively characterized by having turned the side which constitutes the polygon concerned in the random direction while having the flat-surface configuration of an abbreviation polygon.
[Claim 2] It is the electro-optic device characterized by said toothing stratification consisting of a photopolymer layer in claim 1.
[Claim 3] The electro-optic device characterized by forming the interlayer for smoothing the shape of toothing of said concavo-convex pattern in the front face of said toothing stratification in claims 1 or 2, and forming said reflective film in the front face of this interlayer.
[Claim 4] It is the electro-optic device characterized by said toothing stratification being a configuration with the smooth edge of said irregularity in claims 1 or 2.
[Claim 5] It is the electro-optic device characterized by equipping respectively two or more irregularity of said toothing stratification with the same flat-surface configuration in claim 1 thru/or either of 4.
[Claim 6] Two or more irregularity of said toothing stratification is electro-optic devices characterized by having the flat-surface configuration which made it rotate so that the neighboring sense may shift the polygon of the same configuration respectively in claim 5.
[Claim 7] It is the electro-optic device characterized by equipping two or more irregularity of said toothing stratification with the flat-surface configuration of an approximate regular hexagon thru/or a **** octagon in claim 1 thru/or either of 6.
[Claim 8] The electro-optic device which uses said substrate as the 1st substrate, is made to carry out opposite arrangement of the 2nd substrate to this 1st substrate in claim 1 thru/or either of 7, and is characterized by coming to hold the liquid crystal as said electrooptic material between the substrates concerned.
[Claim 9] Electronic equipment characterized by coming as a display to have the electro-optic device specified to claim 1 thru/or either of 8.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the electro-optic device with which electrooptic material was held at the substrate, and the electronic equipment using it. It is related with the concavo-convex formation technique for forming the reflector of light-scattering nature in the substrate used for the electro-optic device in more detail.
[0002]
[Description of the Prior Art] Electro-optic devices, such as liquid crystal equipment, are used as a display of the direct viewing type of various devices. Among such electro-optic devices, with the liquid crystal equipment of a active-matrix mold, as shown in drawing 18 , while the TFT array substrate 10 and the opposite substrate 20 by which opposite arrangement was carried out are stuck by the sealant (not shown), the liquid crystal 50 as electrooptic material is held in the field divided by the sealant between substrates.
[0003] moreover, with the liquid crystal equipment of a reflective mold, or a transflective and a half reflective mold Light reflex film 8a for turning to the direction of the opposite substrate 20 the outdoor daylight which has carried out incidence, and reflecting in the front face of the TFT array substrate 10 from the opposite substrate 20 side, is formed in the lower layer side of transparent pixel electrode 9a. The light which carried out incidence from the opposite substrate 20 side is reflected by the TFT array substrate 10 side, and an image is displayed by the light by which outgoing radiation was carried out from the opposite substrate 10 side.
[0004] In the liquid crystal equipment which performs image display in such reflective mode, if the directivity of light reflected by light reflex film 8a is strong, an angle-of-visibility dependency, like brightness differs at the include angle which sees an image will come out notably. Then, after applying more thickly to the front face of the 2nd interlayer insulation film 5 (surface protective coat) conventionally the photopolymer which consists of organic system resin, such as acrylic resin, By forming toothing stratification 13a equipped with two or more irregularity which carries out patterning of this photopolymer with a photolithography technique, and is from hole 13b (or projection) on the lower layer side of light reflex film 8a Concavo-convex pattern 8g for light scattering is formed in the front face of light reflex film 8a formed in the upper layer side. Moreover, after applying fluid ingredients, such as polysilazane and organic system resin, to the upper layer side of toothing stratification 13a, forming interlayer 7a, making it the edge of toothing stratification 13a etc. not appear in concavo-convex pattern 8g, not forming an interlayer but forming toothing stratification 13a, the configuration of toothing stratification 13a is smoothed to some extent according to the BEKU process.
[0005] In such a manufacture approach, although it is desirable to consider as elliptical [which does not have an angle about the flat-surface configuration of the irregularity (hole 13b) of toothing stratification 13a / the circle configuration or elliptical], for creating such an exposure mask, mask data will become huge. So, in forming toothing stratification 13a using the photopolymer of NEGATAIPU, the exposure mask with which parts for many polygonal translucent part were formed is created, this exposure mask is used, and a photopolymer is exposed and developed, and as shown in drawing 19 (A) and (B), it forms toothing stratification 13a equipped with the irregularity which a flat-surface configuration becomes from two or more polygonal hole 13b. Here, two or more hole 13b has the flat-surface configuration where side 13b' which constitutes a polygon was respectively turned in the same direction.

[0006]
[Problem(s) to be Solved by the Invention] However, when side 13b' which constitutes a polygon is suitable in the same direction in each of two or more hole 13b like before, the trouble that direction dependency occurs is in a light-scattering property so that a reason may be explained below.
[0007] As shown in drawing 20 (A), namely, hole 13b of the polygon currently formed in toothing stratification 13a In the X-X' cross section of light reflex film 8a when cutting in the direction of X-X' which intersects perpendicularly with side 13b' which counters The inclination of a long part and a side face has a gently-sloping dimension B, and a specular reflection component has the strong one where the inclination of a side face is more gently-sloping in the Y-Y' cross section of light reflex film 8a when cutting in the direction of Y-Y' to which the angles which counter are connected to the inclination of a part with short dimension a and a side face being steep. However, in the conventional concavo-convex pattern 8a, in each hole 13b, since side 13b' which constitutes a polygon is suitable in the same direction, the direction where the inclination of a side face is steep, and the direction where the inclination of a side face is gently-sloping have gathered. So, as a continuous line L1 shows to drawing 20 R> 0 (B), when it inclines in the direction of X-X' from a perpendicular direction (0 degree) to a substrate, the fall of dispersion reflectivity is loose, but since the fall of dispersion reflectivity is steep when it inclines in the direction of Y-Y' as a dotted line L2 shows to drawing 20 (B), direction dependency occurs in a dispersion property.
[0008] In view of the above trouble, the technical problem of this invention is by canceling the direction dependency of a dispersion property to offer the electro-optic device which can display the high image of grace, and the electronic equipment using it, when the irregularity formed using the photolithography technique gives dispersion nature to the reflected light.
[0009]
[Means for Solving the Problem] The toothing stratification which forms two or more irregularity which is from a projection or a hole on the front-face side of the substrate holding electrooptic material in this invention in order to solve the above-mentioned technical problem; In the electro-optic device with which it has the light reflex film formed in the field which laps with toothing stratification and a flat-surface target concerned in the upper layer side of this toothing stratification, and two or more irregularity of said toothing stratification comes to form the concavo-convex pattern for light scattering in the front face of this light reflex film Respectively, two or more irregularity of said toothing stratification is characterized by having turned the side which constitutes the polygon concerned in the random direction while it has the flat-surface configuration of an abbreviation polygon.
[0010] Although toothing stratification equipped with two or more irregularity which a flat surface becomes from a polygonal projection or a polygonal hole with a photolithography technique is formed and the concavo-convex pattern for light scattering is formed in the front face of the light reflex film by this toothing stratification in this invention, the irregularity of toothing stratification has the flat-surface configuration where the side which constitutes a polygon was respectively turned in the random direction. For this reason, in the cross section of the light reflex film when cutting the irregularity of toothing stratification by different 2-way, though a difference is in the inclination of a side face and direction dependency is in a light-scattering property in each of concavo-convex, the direction dependency for every irregularity is offset, in view of the concavo-convex whole pattern. So, in the electro-optic device which applied this invention, since there is no direction dependency in a dispersion property, the high display of grace can be performed.
[0011] In this invention, said toothing stratification consists of for example, photopolymer layers. Thus, if constituted, toothing stratification can be formed only by exposing and developing directly the photopolymer applied to the front-face side of a substrate at a photograph RISOSOGURAFI process unlike the case where carry out patterning of other layers with a resist mask, and toothing stratification is formed.
[0012] In this invention, in order for the edge of toothing stratification etc. to appear in a concavo-

convex pattern, to twist and to make it like, after applying fluid ingredients, such as polysilazane and organic system resin, to the upper layer side of toothing stratification, forming an interlayer, and forming the light reflex film in the front face or forming toothing stratification, the edge of toothing stratification is made into a smooth configuration according to a BEKU process.

[0013] As for two or more irregularity of said toothing stratification, in this invention, it is desirable respectively to have the same flat-surface configuration. Thus, since what is necessary is just to copy a part for a translucent part and the protection-from-light part for forming irregularity to toothing stratification as it is in case an exposure mask is formed when constituted, the exposure mask equipped with many parts for a translucent part and protection-from-light parts can be created efficiently.

[0014] As for two or more irregularity of said toothing stratification, in this invention, it is desirable to have the flat-surface configuration which rotated the polygon of the same configuration respectively so that the neighboring sense might shift. Thus, if constituted, the exposure mask which turned to a part for a translucent part and the protection-from-light part for forming irregularity in toothing stratification in the direction where the side of a part for a translucent part and a protection-from-light part is random only by shifting the include angle as it is can be created easily.

[0015] In this invention, two or more irregularity of said toothing stratification is equipped with the flat-surface configuration of an approximate regular hexagon thru/or a **** octagon.

[0016] In this invention, said electrooptic material is liquid crystal. in this case, said transparence substrate -- the 1st transparence substrate -- carrying out -- this -- opposite arrangement of the 2nd transparence substrate is carried out to the 1st transparence substrate, and the liquid crystal as said electrooptic material is made to hold between the substrates concerned

[0017] The electro-optic device which applied this invention can be used as a display of electronic equipment, such as a portable telephone and a mobile computer.

[0018]

[Embodiment of the Invention] The gestalt of operation of this invention is explained with reference to a drawing.

[0019] (Fundamental configuration of an electro-optic device) Drawing 1 is the top view which looked at the electro-optic device which applied this invention from the opposite substrate side with each component, and drawing 2 is the H-H' sectional view of drawing 1 . Drawing 3 is representative circuit schematics, such as various components in two or more pixels formed in the shape of a matrix in the image display field of an electro-optic device, and wiring. In addition, in order to make each class and each part material into the magnitude of extent which can be recognized on a drawing, scales are made to have differed for each class or every each part material in each drawing used for explanation of this gestalt.

[0020] In drawing 1 and drawing 2 , as for the electro-optic device 100 (liquid crystal equipment) of this gestalt, the liquid crystal 50 as electrooptic material is pinched in the field (liquid crystal enclosure field) where the TFT array substrate 10 (the 1st substrate) and the opposite substrate 20 (the 2nd substrate) were stuck by the sealant 52, and were divided by this sealant 52. The circumference abandonment 53 which consists of a protection-from-light nature ingredient is formed in the inside field of the formation field of a sealant 52. The data-line drive circuit 101 and the mounting terminal 102 are formed in the field of the outside of a sealant 52 along with one side of the TFT array substrate 10, and the scanning-line drive circuit 104 is formed in it along with two sides which adjoin this one side. Two or more wiring 105 for connecting between the scanning-line drive circuits 104 established in the both sides of an image display field is formed in one side in which the TFT array substrate 10 remains, and a precharge circuit and an inspection circuit may be further prepared using the bottom of the circumference abandonment 53 etc. Moreover, in at least one place of the corner section of the opposite substrate 20, the substrates flow material 106 for taking an electric flow between the TFT array substrate 10 and the opposite substrate 20 is formed.

[0021] In addition, you may make it connect electrically and mechanically the TAB (tape automated **

bonding) substrate with which LSI for a drive was mounted instead of forming the data-line drive circuit 101 and the scanning-line drive circuit 104 on the TFT array substrate 10 through the anisotropy electric conduction film to the terminal block formed in the periphery of the TFT array substrate 10. In addition, although a polarization film, a phase contrast film, a polarizing plate, etc. are arranged in an electro-optic device 100 at the predetermined sense according to the exception in in the mode of operation of **, and a normally white mode / normally black modes, such as the class of liquid crystal 50 to be used, i.e., TN (Twisted Nematic) mode, and STN (super TN) mode, illustration is omitted here.
[0022] Moreover, in constituting an electro-optic device 100 as an object for color displays, in the opposite substrate 20, it forms the color filter of RGB in the field which counters each pixel electrode (it mentions later) of the TFT array substrate 10 with the protective coat.
[0023] In the image display field of the electro-optic device 100 which has such structure As shown in drawing 3 , while two or more pixel 100a is constituted in the shape of a matrix, to each of such pixel 100a TFT30 for the pixel switching for driving pixel electrode 9a and this pixel electrode 9a is formed, and they are the pixel signals S1 and S2... Data-line 6a which supplies Sn is electrically connected to the source concerned of TFT30. Pixel signals S1 and S2 written in data-line 6a ... Sn may be supplied to line sequential and you may make it supply it to this order for every group to two or more data-line 6a which adjoin each other. Moreover, scanning-line 3a is electrically connected to the gate of TFT30, and they are the scan signals G1 and G2 in [in predetermined timing / scanning-line 3a] pulse... It is constituted so that Gm may be impressed to this order by line sequential. Pixel electrode 9a is the pixel signals S1 and S2 supplied from data-line 6a, when it connects with the drain of TFT30 electrically and only a fixed period makes TFT30 which is a switching element the ON state... Sn is written in each pixel to predetermined timing. thus, the pixel signals S1 and S2 of the predetermined level written in liquid crystal through pixel electrode 9a and ... fixed period maintenance of the Sn is carried out between the counterelectrodes 21 of the opposite substrate 20 shown in drawing 2 .
[0024] Here, when the orientation and order of molecular association change with the voltage levels impressed, liquid crystal 50 modulates light and enables a gradation display. The quantity of light to which incident light will pass the part of this liquid crystal 50 according to the impressed electrical potential difference if it is in no MARI White mode falls, and if it is in NOMA reeve rack mode, the quantity of light to which incident light passes the part of this liquid crystal 50 according to the impressed electrical potential difference increases. consequently -- as a whole -- the pixel signals S1 and S2 from an electro-optic device 100, and ... outgoing radiation of the light with the contrast according to Sn is carried out.
[0025] in addition, the held pixel signals S1 and S2 and ... in order to prevent Sn leaking, storage capacitance 60 may be added to the liquid crystal capacity and juxtaposition which are formed between pixel electrode 9a and a counterelectrode For example, as for the electrical potential difference of pixel electrode 9a, only time amount also with triple figures longer than the time amount to which the source electrical potential difference was impressed is held with storage capacitance 60. Thereby, it is improved and the maintenance property of a charge can realize the high electro-optic device 100 of a contrast ratio. In addition, as an approach of forming storage capacitance 60, as illustrated to drawing 3 , when forming between capacity line 3b which is wiring for forming storage capacitance 60, or also when forming between scanning-line 3a of the preceding paragraph, you may be any.
[0026] (Configuration of a TFT array substrate) Drawing 4 is a top view of two or more pixel groups where the TFT array substrate used for the electro-optic device of this gestalt adjoins each other. Drawing 5 is a sectional view when cutting a part of pixel of an electro-optic device in the location equivalent to the A-A' line of drawing 4 .
[0027] In drawing 4 , on the TFT array substrate 10, pixel electrode 9a which consists of two or more transparent ITO (Indium Tin Oxide) film is formed in the shape of a matrix, and TFT30 for pixel switching has connected to each [these] pixel electrode 9a, respectively. Moreover, along the boundary of pixel electrode 9a in every direction, data-line 6a, scanning-line 3a, and capacity line 3b were formed, and

TFT30 is connected to data-line 6a and scanning-line 3a. That is, data-line 6a was electrically connected to 1d of high concentration source fields of TFT30 through the contact hole, and pixel electrode 9a is electrically connected to high concentration drain field 1e of TFT3 through a contact hole. Moreover, scanning-line 3a is prolonged so that channel field 1a' of TFT30 may be countered. In addition, storage capacitance 60 (are recording capacitative element) uses as a bottom electrode what electric-conduction-ized 1f of installation parts of the semi-conductor film 1 for forming TFT30 for pixel switching, and has structure to which scanning-line 3b and capacity line 3b of this layer lapped with the bottom [this] electrode 41 as an upper electrode.

[0028] Thus, the field surrounded by alternate long and short dash line 8' in each constituted pixel 100a among the fields in which pixel electrode 9a is formed is a transparency field which displays by the transparent mode, and the toothing stratification and the light-reflex film which are mentioned later are not formed, but other fields are reflective fields equipped with the toothing stratification and the light-reflex film mentioned later, and display in reflective mode here.

[0029] the cross section in the A-A' line of this reflective field is shown in drawing 5 -- as -- the TFT array substrate 10 -- a base -- the substrate protective coat 11 which thickness becomes from the silicon oxide (insulator layer) which is 300nm - 500nm is formed in the transparent front face of substrate 10', and semi-conductor film 1a of the shape of an island whose thickness is 50nm - 100nm is formed in the front face of this substrate protective coat 11. Gate-dielectric-film 2a which thickness becomes from the silicon oxide which is about 50-150nm is formed in the front face of semi-conductor film 1a, and scanning-line 3a whose thickness is 300nm - 800nm passes as a gate electrode on the front face of this gate-dielectric-film 2a. The field which confronts each other through gate-dielectric-film 2a among semi-conductor film 1a to scanning-line 3a is channel field 1a'. To this channel field 1a', a source field equipped with low concentration source field 1b and 1d of high concentration source fields is formed in one side, and the drain field equipped with low concentration drain field 1c and high concentration drain field 1e is formed in the other side.

[0030] The 1st interlayer insulation film 4 with which thickness consists of silicon oxide which is 300nm - 800nm, and the 2nd interlayer insulation film 5 (surface protective coat) with which thickness consists of a silicon nitride which is 100nm - 300nm are formed in the front-face side of TFT30 for pixel switching. Data-line 6a whose thickness is 300nm - 800nm was formed in the front face of the 1st interlayer insulation film 4, and this data-line 6a is electrically connected to it through the contact hole formed in the 1st interlayer insulation film 4 at 1d of high concentration source fields. Drain electrode 6b by which coincidence formation was carried out with data-line 6a was formed in the front face of the 1st interlayer insulation film 4, and this drain electrode 6b is electrically connected to high concentration drain field 1e through the contact hole formed in the 1st interlayer insulation film 4.

[0031] Toothing stratification 13a and interlayer 7a which consist of photopolymers, such as organic system resin, are formed in this order, and light reflex film 8a which consists of aluminum film etc. is formed in the front face of this interlayer 7a at the upper layer of the 2nd interlayer insulation film 5 so that it may mention later.

[0032] Transparent pixel electrode 9a which consists of ITO film is formed in the upper layer of light reflex film 8a. The laminating of the pixel electrode 9a is directly carried out to the front face of light reflex film 8a, and pixel electrode 9a and light reflex film 8a are connected electrically. Moreover, pixel electrode 9a is electrically connected to drain electrode 6b through the contact hole formed in interlayer 7a and the 2nd interlayer insulation film 5.

[0033] The orientation film 12 which consists of polyimide film is formed in the front-face side of pixel electrode 9a. This orientation film 12 is film with which rubbing processing was performed to the polyimide film.

[0034] Moreover, to 1f (bottom electrode) of installation parts from high concentration drain field 1e, through the insulator layer (dielectric film) by which coincidence formation was carried out with gate-dielectric-film 2a, when scanning-line 3a and capacity line 3b of this layer counter as an upper electrode,

storage capacitance 60 is constituted.
[0035] In addition, although TFT30 has LDD structure as mentioned above preferably, it may have the offset structure which does not drive impurity ion into the field equivalent to low concentration source field 1b and low concentration drain field 1c. Moreover, TFT30 may be TFT of the self aryne mold which drove in impurity ion by high concentration by having used the gate electrode (a part of scanning-line 3a) as the mask, and formed the high-concentration source and a high-concentration drain field in self align.
[0036] Moreover, although considered as the single gate structure which has arranged one gate electrode (scanning-line 3a) of TFT30 between source-drain fields with this gestalt, two or more gate electrodes may be arranged among these. Under the present circumstances, to each gate electrode, the same signal is made to be impressed. Thus, if TFT30 is constituted above the dual gate (double-gate) or the triple gate, the leakage current in the joint of a channel and a source-drain field can be prevented, and the current at the time of OFF can be reduced. If at least one of these gate electrodes is made into LDD structure or offset structure, the OFF state current can be reduced further and the stable switching element can be obtained.
[0037] (Configuration of a concavo-convex pattern) Drawing 6 (A) and (B) are the perspective view showing typically the front face of the toothing stratification formed in the TFT array substrate 10 used for the electro-optic device 100 of this gestalt, and its top view.
[0038] In drawing 4 and drawing 5 , concavo-convex pattern 8g equipped with heights 8b and crevice 8c is formed in the field (light reflex film formation field) from which it separated from the formation field of TFT30 among the front faces of light reflex film 8a in the reflective field of each pixel 100a with the TFT array substrate 10.
[0039] In constituting such concavo-convex pattern 8g in the TFT array substrate 10 of this gestalt In the field which laps with light reflex film 8a superficially in by the side of the lower layer of light reflex film 8a Toothing stratification 13a which consists of a photopolymer of an organic system is more thickly formed in the front face of the 2nd interlayer insulation film 5, and the laminating of the interlayer 7a which consists of an insulator layer formed from fluid ingredients, such as polysilazane and organic system resin, is carried out to the upper layer of this toothing stratification 13a.
[0040] As shown in drawing 6 (A) and (B), the irregularity which consists of much hole 13b is formed in toothing stratification 13a. For this reason, as shown in drawing 5 , concavo-convex pattern 8g corresponding to the irregularity (hole 13b) of toothing stratification 13a is formed in the front face of reflective film 8a, and the edge of toothing stratification 13a etc. comes out to it by interlayer 7a by this concavo-convex pattern 8g. In addition, after forming toothing stratification 13a, without forming interlayer 7a, the edge of the irregularity (hole 13b) of toothing stratification 13a may be smoothed by performing a BEKU process.
[0041] Here, although each of hole 13b of toothing stratification 13a has the flat-surface configuration of an abbreviation polygon called a **** octagon etc. as shown in drawing 6 (A) and (B), in this flat-surface configuration, hole 13b has turned side 13b' in the random direction respectively. That is, respectively, although two or more irregularity (hole 13b) of toothing stratification 13a is equipped with the same flat-surface configuration, two or more hole 13b has the flat-surface configuration which rotated the polygon of the same configuration respectively so that the sense of side 13b' might shift.
[0042] (Configuration of an opposite substrate) In drawing 5 , with the opposite substrate 20, the light-shielding film 23 called a black matrix or a black stripe is formed in the border area of pixel electrode 9a currently formed in the TFT array substrate 10 in every direction, and the field which counters, and the counterelectrode 21 which consists of ITO film is formed in the upper layer side. Moreover, the orientation film 22 which consists of polyimide film is formed in the upper layer side of a counterelectrode 21, and this orientation film 22 is film with which rubbing processing was performed to the polyimide film.
[0043] (Operation of the electro-optic device of this gestalt) In the electro-optic device 100 constituted

in this way, light reflex film 8a which is from the aluminum film etc. on the lower layer side of pixel electrode 9a is formed. For this reason, since the light which carried out incidence from the opposite substrate 20 side is reflected by the TFT array substrate 10 side and outgoing radiation can be carried out from the opposite substrate 20 side, if liquid crystal 50 performs light modulation by each pixel 100a of every in the meantime, a desired image can be displayed using outdoor daylight (reflective mode).
[0044] Moreover, in an electro-optic device 100, since light reflex film 8a is formed so that the field surrounded by alternate long and short dash line 8' by drawing 4 R> 4 may be avoided, it functions also as liquid crystal equipment of transflective and a half reflective mold. That is, after carrying out incidence of the light by which outgoing radiation was carried out from the back light equipment (not shown) arranged at the TFT array substrate 10 side to the TFT array substrate 10 side, it is penetrated to the opposite substrate 20 side through the transparency field in which light reflex film 8a is not formed among the fields in which pixel electrode 9a is formed in each pixel 100a. For this reason, if liquid crystal 50 performs light modulation by each pixel 100a of every, a desired image can be displayed from back light equipment using the light by which outgoing radiation was carried out (transparent mode).
[0045] Moreover, with this gestalt, toothing stratification 13a is formed in the field which laps with light reflex film 8a superficially in by the side of the lower layer of light reflex film 8a, and concavo-convex pattern 8g for light scattering is formed in the front face of light reflex film 8a using the irregularity corresponding to hole 13b of this toothing stratification 13a. Moreover, in concavo-convex pattern 8g, the edge of toothing stratification 13a etc. comes out by interlayer 7a. Therefore, when an image is displayed in reflective mode, in order to display an image by the dispersion reflected light, an angle-of-visibility dependency is small.
[0046] Furthermore, although hole 13b of toothing stratification 13a all has the flat-surface configuration of an abbreviation polygon called a **** octagon etc. as explained with reference to drawing 6 (A) and (B), in this flat-surface configuration, hole 13b has turned side 13b' in the random direction respectively. For this reason, the X-X' cross section of light reflex film 8a when cutting hole 13b of the polygon currently formed in toothing stratification 13a in the direction of X-X' which intersects perpendicularly with side 13b' which counters, as explained with reference to drawing 2020 (A) and (B), Since the inclinations of a side face differ between the Y-Y' cross sections of light reflex film 8a when cutting in the direction of Y-Y' to which the angles which counter are connected and a specular reflection component has the strong one where the inclination of a side face is more gently-sloping, In each of the irregularity corresponding to hole 13b, even if direction dependency is in light scattering, the direction dependency for every irregularity is offset, in view of the whole concavo-convex pattern 8g. So, in the electro-optic device 100 of this gestalt, since there is no direction dependency in the optical reinforcement which carried out scatter reflection by light reflex film 8a in case an image is displayed in reflective mode, the high image of grace can be displayed.
[0047] [the manufacture approach of TFT] -- how to manufacture the TFT array substrate 10 of such a configuration is explained with reference to drawing 7 thru/or drawing 11 R> 1, and drawing 12 . All, drawing 7 thru/or drawing 11 R> 1 are the process sectional views showing the manufacture approach of the TFT array substrate 11 of this gestalt, and has shown the cross section of a TFT formation field and a light reflex film formation field (reflective field) also in which drawing. Drawing 12 is the explanatory view showing the mask pattern of the exposure mask used for forming toothing stratification 13b from a photopolymer using a photolithography technique in the manufacture approach of the TFT array substrate 10 of this gestalt.
[0048] First, as shown in drawing 7 (A), after preparing substrate 10', such as glass [which was defecated by ultrasonic cleaning etc.], substrate temperature forms in the thickness of 300nm - 500nm the substrate protective coat 11 which consists of silicon oxide by the plasma-CVD method all over substrate 10' under the temperature conditions which are 150 degrees C - 450 degrees C. As material gas at this time, the mixed gas of a mono silane and laughter gas, TEOS and oxygen or a disilane, and ammonia can be used, for example.

[0049] Next, substrate temperature forms in the thickness of 50nm - 100nm the semi-conductor film 1 which consists of amorphous silicon film by the plasma-CVD method all over substrate 10' under the temperature conditions which are 150 degrees C - 450 degrees C. As material gas at this time, a disilane and a mono silane can be used, for example. Next, a laser beam is irradiated to the semi-conductor film 1, and laser annealing is given. Consequently, the amorphous semi-conductor film 1 is fused once, and is crystallized through a cooling solidification process. In this case, the irradiation time of the laser beam to each field is very a short time, and to the whole substrate, since it is local, an exposure field is not heated for the whole substrate by coincidence at an elevated temperature, either. So, even if it uses a glass substrate etc. as substrate 10', deformation, a crack, etc. by heat do not arise.
[0050] Next, by using a photolithography technique for the front face of the semi-conductor film 1, forming the resist mask 551, and etching the semi-conductor film 1 through this resist mask 551, as shown in drawing 7 (B), the semi-conductor film for forming island-like semi-conductor film 1a (active layer) and 1g of light-shielding films is formed in the condition of having dissociated respectively.
[0051] Next, the gate dielectric film 2 which becomes the front face of semi-conductor film 1a from silicon oxide etc. with a CVD method etc. is formed in the thickness of 50nm - 150nm all over substrate 10' under temperature conditions 350 degrees C or less. The mixed gas of TEOS and oxygen gas can be used for the material gas at this time. The gate dielectric film 2 formed here may be replaced with silicon oxide, and may be a silicon nitride.
[0052] Next, although illustration is omitted, impurity ion is driven into 1f of installation parts of semi-conductor film 1a through a predetermined resist mask, and the bottom electrode for constituting storage capacitance 60 between capacity line 3b is formed.
[0053] Next, by a spatter etc., as shown in drawing 7 (C), after forming in the thickness of 300nm - 800nm the aluminum film for forming scanning-line 3a etc., the tantalum film, the molybdenum film, or the electric conduction film 3 that consists of alloy film which uses either of these metals as a principal component all over substrate 10', the resist mask 552 is formed using a photolithography technique.
[0054] Next, as dry etching of the electric conduction film 3 is carried out and it is shown in drawing 7 (D) through the resist mask 552, scanning-line 3a (gate electrode), capacity line 3b, etc. are formed.
[0055] Next, they are about 0.1x1013-/cm2 - about 10x1013-/cm2, using scanning-line 3a and a gate electrode as a mask at the pixel TFT section and N channel TFT section (not shown) side of a drive circuit. Impurity ion (phosphorus ion) low-concentration with a dose is driven in, and low concentration source field 1b and low concentration drain field 1c are formed in self align to scanning-line 3a. Here, since it is located just under scanning-line 3a, the part into which impurity ion was not introduced becomes channel field 1a' with semi-conductor film 1a.
[0056] Next, as shown in drawing 8 (A), in the pixel TFT section, the resist mask 553 with wide width of face is formed from scanning-line 3a (gate electrode), and they are about 0.1x1015-/cm2 - about 10x1015-/cm2 about high-concentration impurity ion (phosphorus ion). It is devoted with a dose and high concentration source field 1b and 1d of drain fields are formed.
[0057] It may replace with these impurity installation processes, the high-concentration impurity (phosphorus ion) in the condition of having formed the resist mask with width of face wider than a gate electrode, without driving in a low-concentration impurity may be driven in, and the source field and drain field of offset structure may be formed. Moreover, scanning-line 3a may be used as a mask, a high-concentration impurity may be driven in, and, of course, the source field and drain field of self aryne structure may be formed.
[0058] In addition, although illustration is omitted, and the N channel TFT section of the circumference drive circuit section is formed according to such a process, in this case, the P channel TFT section is covered with the mask. Moreover, they are about 0.1x1015-/cm2 - about 10x1015-/cm2, carrying out covering protection of the pixel section and the N channel TFT section by the resist, and using a gate electrode as a mask, in case the P channel TFT section of a circumference drive circuit is formed. By driving in boron ion with a dose, the source drain field of a P channel is formed in self align. Under the

present circumstances, a gate electrode is used as a mask like the time of formation of the N channel TFT section. About 0.1x1013-/cm2 - about 10x1013-/cm2 An impurity (boron ion) low-concentration with a dose is introduced. A mask with width of face wider than a gate electrode after forming a low concentration field in the polish recon film is formed, and they are about 0.1x1015-/cm2 - about 10x1015-/cm2 about a high-concentration impurity (boron ion). It is devoted with a dose. The source field and drain field of LDD structure (the Rheydt Lee doped drain structure) may be formed. Moreover, the high-concentration impurity (phosphorus ion) in the condition of having formed the mask with width of face wider than a gate electrode may be driven in without driving in a low-concentration impurity, and the source field and drain field of offset structure may be formed. According to these ion implantation processes, CMOS-ization is attained and the built-in of it into the same substrate of a circumference drive circuit is attained.

[0059] Next, as shown in drawing 8 (B), the 1st interlayer insulation film 4 which consists of silicon oxide etc. is formed in the front-face side of scanning-line 3a with a CVD method etc. at the thickness of 300nm - 800nm. The mixed gas of TEOS and oxygen gas can be used for the material gas at this time.

[0060] Next, the resist mask 554 is formed using a photolithography technique.

[0061] Next, dry etching is performed to the 1st interlayer insulation film 4 through the resist mask 554, and as shown in drawing 8 (C), in the 1st interlayer insulation film 4, a contact hole is formed in the part corresponding to a source field and a drain field etc., respectively.

[0062] Next, as shown in drawing 8 (D), after forming in the thickness of 300nm - 800nm the electric conduction film 6 which consists of the aluminum film for constituting data-line 6a (source electrode) etc., the tantalum film, molybdenum film, or alloy film that uses either of these metals as a principal component by a spatter etc., the resist mask 555 is formed in the front-face side of the 1st interlayer insulation film 4 using a photolithography technique.

[0063] Next, dry etching is performed on the electric conduction film 6 through the resist mask 555, and as shown in drawing 9 (A), data-line 6a and drain electrode 6b are formed.

[0064] Next, as shown in drawing 9 (B), the resist mask 556 for forming a contact hole etc. in the front-face side of data-line 6a and drain electrode 6b with a CVD method etc., at the 2nd interlayer insulation film 5 using a photolithography technique, after forming in 100nm - 300nm thickness the 2nd interlayer insulation film 5 which consists of a silicon nitride or organic system resin is formed.

[0065] Next, dry etching is performed to the 2nd interlayer insulation film 5 through the resist mask 556, and as shown in drawing 9 (C), a contact hole is formed in the part corresponding to the drain electrode 14 among the 2nd interlayer insulation film 5.

[0066] As shown in drawing 10 (A), after applying the photopolymer 13 of an organic system to the front face of the 2nd interlayer insulation film 5 more thickly, next, by carrying out patterning of the photopolymer 13 using a photolithography technique As shown in drawing 10 (B), toothing stratification 13a equipped with hole 13b of a large number explained with reference to drawing 6 (A) and (B) is formed in the field which laps with light reflex film 8a superficially in by the side of the lower layer of light reflex film 8a.

[0067] Although any of NEGATAIPU and POJITAIPU may be used as a photopolymer 13 in case toothing stratification 13a is formed using such a photolithography technique, to drawing 10 (A), the case of POJITAIPU is illustrated as a photopolymer 13, and ultraviolet rays are irradiated to the part which wants to remove a photopolymer 13 through a part for the translucent part 511 of the exposure mask 510 later mentioned with reference to drawing 12 .

[0068] Next, as shown in drawing 10 (C), after applying the fluid ingredient 7 which calcinates or consists of organic system resin after applying the constituent which contains perhydro polysilazane or this in the 2nd interlayer insulation film 5 and front-face side of toothing stratification 13a, as it is made to harden, next is shown in drawing 10 (D), interlayer 7a equipped with the contact hole is formed using a photolithography technique.

[0069] In addition, perhydro polysilazane is a kind of inorganic polysilazane and is a spreading mold

coating ingredient converted into silicon oxide by calcinating in atmospheric air. For example, the polysilazane by TONEN CORP. is inorganic polymer which makes -(SiH2 NH)- a unit, and is meltable to organic solvents, such as a xylene. Therefore, if it calcinates in atmospheric air at the temperature of 450 degrees C after applying with a spin coat method (for example, for 2000rpm and 20 seconds) by using the organic solvent solution (for example, 20% xylene solution) of this inorganic polymer as coating liquid, it can react with moisture and oxygen and the silicon oxide which formed membranes with the CVD method, and the precise amorphous silicon oxide more than equivalent can be obtained.

[0070] Here, since interlayer 7a is formed from what applied the ingredient which has a fluidity, the irregularity of toothing stratification 13a is moderately negated in the front face of interlayer 7a, and concavo-convex pattern 8g of a gently-sloping configuration without an edge is formed in it.

[0071] In addition, what is necessary is to perform a BEKU process in the condition which shows in drawing 10 (B), and just to make the edge of hole 13b of toothing stratification 13a into a smooth configuration, in forming concavo-convex pattern 8g of a gently-sloping configuration, without forming interlayer 7a.

[0072] Next, by a spatter etc., as shown in drawing 11 (A), after forming the metal membrane 8 equipped with the reflexibility of the aluminum film etc. in the front face of interlayer 7a, the resist mask 557 is formed using a photolithography technique.

[0073] Next, it etches into a metal membrane 8 through the resist mask 557, and as shown in drawing 11 (B), it leaves light reflex film 8a to a predetermined field. Thus, 800 morenm [500nm or more and] or more concavo-convex pattern 8g is formed in the front face of formed light reflex film 8a of the irregularity which consists of hole 13b of toothing stratification 13a, and it has become a gently-sloping configuration without an edge by interlayer 7a this concavo-convex pattern 8g.

[0074] Next, as shown in drawing 11 (C), after thickness forms the ITO film 9 which is 40nm - 200nm by a spatter etc., the resist mask 558 is formed in the front-face side of light reflex film 8a using a photolithography technique.

[0075] Next, it etches into the ITO film 9 through the resist mask 558, and as shown in drawing 11 (D), pixel electrode 9a electrically connected to drain electrode 6b is formed.

[0076] As shown in after an appropriate time at drawing 5 , the polyimide film (orientation film 12) is formed in the front-face side of pixel electrode 9a. It heats and hardens, after carrying out flexographic printing of the polyimide varnish made to dissolve 5 - 10% of the weight of polyimide, and a polyamide acid in solvents, such as butyl cellosolve and n-methyl pyrrolidone, to it (baking). And the substrate in which the polyimide film was formed is ground in the fixed direction with the puff cloth which consists of rayon system fiber, and a polyimide molecule is made to arrange in the fixed direction near the front face. Consequently, a liquid crystal molecule arranges in the fixed direction by the interaction of the liquid crystal molecule and polyimide molecule filled with later.

[0077] Consequently, the TFT array substrate 10 is completed.

[0078] (Configuration of the exposure mask 510) At the exposure process explained with reference to drawing 10 (A) among these production processes, a photopolymer 13 is exposed using the exposure mask 510 shown in drawing 12 . Parts for two or more translucent part 511 of an abbreviation polygon called a **** octagon etc. were formed to the field corresponding to hole 13b explained to this exposure mask 510 with reference to drawing 6 (A) and (B), and the amount of [511] these translucent parts have turned each side 511' in the random direction. That is, in the exposure mask 510, respectively, although the amount of [511] translucent part has the same flat-surface configuration, it has the configuration which rotated the polygon of the same configuration so that the sense of side 511' might shift.

[0079] For this reason, in case the exposure mask 510 is created, unlike elliptical [without **** the amount of / 511 / whose / translucent part is a polygon, and an angle / a circle configuration or elliptical], a vast quantity of mask data are not needed. Moreover, in the exposure mask 510, respectively, since the amount of [511] translucent part has the same flat-surface configuration, it can

form easily the exposure mask 510 equipped with parts for many translucent part 511 only by copying one translucent part 511 as it is. And since the amount of [511] translucent part has the configuration which rotated the polygon of the same configuration respectively so that the sense of side 511' might shift, it can manufacture the exposure mask 510 with which side 511' for a translucent part 511 was suitable in the random direction only by copying a part for a translucent part 511, shifting an include angle as it is.

[0080] Moreover, with this gestalt, since toothing stratification 13a is constituted from a photopolymer layer, the case where carry out patterning of other layers with a resist mask, and toothing stratification is formed is differed from, and there is an advantage that toothing stratification 13a can be formed only by exposing and developing a photopolymer 13 at a photograph RISOSOGURAFI process directly.

[0081] Although the [gestalt of other operations] above-mentioned gestalt explained toothing stratification 13a equipped with the irregularity which a flat-surface configuration becomes from hole 13b of an octagon to the example, about the flat-surface configuration of hole 13b, the polygon of not only an octagon but others is sufficient. However, when mask data and a dispersion property are taken into consideration, a forward hexagon thru/or the forward octagon of a flat-surface configuration are desirable.

[0082] Moreover, what is necessary is just to use exposure mask 510' shown in drawing 13 , in forming toothing stratification 13a equipped with hole 13b (irregularity) from the photopolymer of NEGATAIPU although the exposure mask 510 for forming in drawing 12 toothing stratification 13a equipped with hole 13b (irregularity) from the photopolymer of POJITAIPU was shown. Two or more protection-from-light parts 512 of an abbreviation polygon called a **** octagon etc. were formed in the field corresponding to hole 13b explained to this exposure mask 510' with reference to drawing 6 (A) and (B), and this protection-from-light part 512 has turned each side 512' in the random direction.

[0083] Furthermore, although toothing stratification 13a in which the irregularity which consists of hole 13b was formed was used with the gestalt of the above-mentioned implementation, as shown in drawing 14 (A) and (B), negatives may be developed by using and exposing a photolithography technique to a photopolymer, and toothing stratification 13a which constitutes the irregularity which consists of projection 13c may be formed. Although each of projection 13c of toothing stratification 13a has the flat-surface configuration of an abbreviation polygon called a **** octagon etc. also in this case, in this flat-surface configuration, projection 13c is respectively taken as the configuration which has turned side 13c' in the random direction.

[0084] Although any above-mentioned gestalt explained the liquid crystal equipment of the active-matrix mold using TFT as a pixel switching element to the example, it may apply this invention to the liquid crystal equipment of the active-matrix mold using TFD as a pixel switching element or the liquid crystal equipment of a passive matrix mold, and the electro-optic device using electrooptic material other than liquid crystal further further again.

[0085] Although the electro-optic device 100 of [application on the electronic equipment of an electro-optic device] thus the constituted reflective mold, or a transflective and a half reflective mold can be used as a display of various kinds of electronic equipment, it explains the example with reference to drawing 15 , drawing 16 , and drawing 17 .

[0086] 15 is the block diagram showing the circuitry of electronic equipment using the electro-optic device concerning this invention as an indicating equipment.

[0087] In drawing 15 , electronic equipment has the source 70 of a display information output, the display information processing circuit 71, a power circuit 72, a timing generator 73, and liquid crystal equipment 74. Moreover, liquid crystal equipment 74 has the liquid crystal display panel 75 and the drive circuit 76. As liquid crystal equipment 74, the electro-optic device 100 mentioned above can be used.

[0088] The source 70 of a display information output is equipped with the tuning circuit which carries out the alignment output of storage units, such as memory, such as ROM (Read Only Memory) and RAM (Random Access Memory), and various disks, and the digital picture signal, and supplies the display

information of the picture signal of a predetermined format etc. to the display information processing circuit 71 based on various kinds of clock signals generated by the timing generator 73.
[0089] The display information processing circuit 71 is equipped with the various circuits of common knowledge, such as a serial-parallel conversion circuit, and magnification and an inverter circuit, a rotation circuit, a gamma correction circuit, a clamping circuit, performs processing of display information in which it inputted, and supplies the picture signal to the drive circuit 76 with a clock signal CLK. A power circuit 72 supplies a predetermined electrical potential difference to each component.
[0090] Drawing 16 shows the personal computer of the mobile mold which is 1 operation gestalt of the electronic equipment concerning this invention. The personal computer 80 shown here has the body section 82 equipped with the keyboard 81, and the liquid crystal display unit 83. The liquid crystal display unit 83 is constituted including the electro-optic device 100 mentioned above.
[0091] Drawing 17 shows the portable telephone which are other operation gestalten of the electronic equipment concerning this invention. The portable telephone 90 shown here has two or more manual operation buttons 91 and the display which consists of an electro-optic device 100 mentioned above.
[0092]
[Effect of the Invention] Although the toothing stratification equipped with two or more irregularity which a flat surface becomes from a polygonal projection or a polygonal hole with a photolithography technique in this invention is formed and the concavo-convex pattern for light scattering is formed in the front face of the light reflex film by this toothing stratification as above, the irregularity of toothing stratification has the flat-surface configuration where the side which constitutes a polygon was respectively turned in the random direction. For this reason, in the cross section of the light reflex film when cutting the irregularity of toothing stratification by different 2-way, though a difference is in the inclination of a side face and direction dependency is in a light-scattering property in each of concavo-convex, the direction dependency for every irregularity is offset, in view of the concavo-convex whole pattern. So, in the electro-optic device which applied this invention, since there is no direction dependency in a dispersion property, the high display of grace can be performed.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is a top view when seeing an electro-optic device from an opposite substrate side.
[Drawing 2] It is a sectional view in the H-H' line of drawing 1 .
[Drawing 3] In an electro-optic device, they are representative circuit schematics formed in two or more pixels arranged in the shape of a matrix, such as various components and wiring.
[Drawing 4] In the electro-optic device which applied this invention, it is the top view showing the configuration of each pixel formed in the TFT array substrate.

[Drawing 5] It is the sectional view of the pixel when cutting in the location equivalent to the A-A' line of drawing 4 .
[Drawing 6] (A) and (B) are the perspective view showing typically the front face of the toothing stratification formed in the TFT array substrate used for the electro-optic device which applied this invention, and its top view.
[Drawing 7] (A) - (D) is the process sectional view showing the manufacture approach of the TFT array substrate of the electro-optic device which applied this invention.
[Drawing 8] (A) - (D) is the process sectional view of each process performed following the process shown in drawing 7 in the manufacture approach of the TFT array substrate of the electro-optic device which applied this invention.
[Drawing 9] (A) - (C) is the process sectional view of each process performed following the process shown in drawing 8 in the manufacture approach of the TFT array substrate of the electro-optic device which applied this invention.
[Drawing 10] (A) - (D) is the process sectional view of each process performed following the process shown in drawing 9 in the manufacture approach of the TFT array substrate of the electro-optic device which applied this invention.
[Drawing 11] (A) - (D) is the process sectional view of each process performed following the process shown in drawing 10 in the manufacture approach of the TFT array substrate of the electro-optic device which applied this invention.
[Drawing 12] It is the explanatory view of the exposure mask used for forming the toothing stratification shown in drawing 6 (A) and (B).
[Drawing 13] It is the explanatory view of another exposure mask usable although the toothing stratification shown in drawing 6 (A) and (B) is formed.
[Drawing 14] (A) and (B) are the perspective view showing typically the front face of another toothing stratification formed in the TFT array substrate used for the electro-optic device which applied this invention, and its top view.
[Drawing 15] It is the block diagram showing the circuitry of electronic equipment using the electro-optic device concerning this invention as an indicating equipment.
[Drawing 16] It is the explanatory view showing the personal computer of the mobile mold as 1 operation gestalt of electronic equipment using the electro-optic device concerning this invention.
[Drawing 17] It is the explanatory view of the portable telephone as 1 operation gestalt of electronic equipment using the electro-optic device concerning this invention.
[Drawing 18] They are some sectional views of the pixel of the conventional electro-optic device.
[Drawing 19] (A) and (B) are the perspective view showing typically the front face of the toothing stratification formed in the TFT array substrate used for the conventional electro-optic device, and its top view.
[Drawing 20] (A) and (B) are the explanatory views for explaining the direction dependency of the dispersion property generated when the toothing stratification in which a flat-surface configuration forms polygonal irregularity is used.
[Description of Notations]
1a Semi-conductor film
1a' Field for channel formation
2 Gate Dielectric Film
3a Scanning line
3b Capacity line
4 1st Interlayer Insulation Film
5 2nd Interlayer Insulation Film
6a Data line
6b Drain electrode

7a Interlayer
8a Light reflex film
9a Pixel electrode
10 TFT Array Substrate
11 Substrate Protective Coat
13 Photopolymer for Forming Toothing Stratification
13a Toothing stratification
13b The hole of toothing stratification (irregularity)
13b' The side of the hole (irregularity) of toothing stratification
13c The projection of toothing stratification (irregularity)
13c' The side of a projection (irregularity) of toothing stratification
20 Opposite Substrate
21 Counterelectrode
30 TFT for Pixel Switching
50 Liquid Crystal
60 Storage Capacitance
100 Electro-optic Device
100a Pixel
510 Exposure Mask
511 A Part for Translucent Part of Exposure Mask
511' The side for a translucent part of an exposure mask
512 Protection-from-Light Part of Exposure Mask
512' The side of the protection-from-light part of an exposure mask

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[Translation done.]